FEMI.209: 180334
ORIGINAL

FLOOD INSURANCE STUDY

COMPLETED
27

TOWN OF MOORESVILLE, INDIANA

MORGAN COUNTY

APRIL 15, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 180334

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

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FLOOD INSURANCE STUDY

TOWN OF MOORESVILLE,
MORGAN COUNTY, INDIANA

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this TYPE 19 Flood Insurance Study is to investigate the existence and severity of flood hazards in the Town of Mooresville, Morgan County, Indiana and to aid the administration of the Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to revise Flood Insurance Rate Maps developed from data presented in the TYPE 15 Flood Insurance Study. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by the Federal Emergency Management Agency. This work, which was completed in April 1981, covered all significant flooding sources affecting the town and its extraterritorial limits.

1.3 Coordination

Community base map selection and the identification of streams requiring detailed study were performed in meetings attended by personnel of Cole Associates Inc., FEMA, the Indiana Department of Natural Resources and officials of the Town of Mooresville in March 1976. Hydrologic analyses and flood profiles for White Lick Creek and East Fork White Lick Creek presented in the Town of Mooresville Type 15 Flood Insurance Study were coordinated by Cole Associates, Inc. with those of the Indiana Department of Natural Resources (Reference 1). During the course of the work, flood elevations, flood boundaries and floodway delineations were reviewed with

community officials and officials of the Indiana Department of Natural Resources. On September 28, 1978, the results of the work on the Type 15 Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by Mooresville town officials and personnel from Cole Associates Inc., FEMA and the Indiana Department of Natural Resources.

A Type 19 Flood Insurance Study was initiated to include areas of flooding within the extraterritorial limits and to update the Type 15 analysis.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area and extraterritorial areas of the Town of Mooresville, Morgan County, Indiana. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through 1983. The scope and methods of study were proposed to and agreed upon by FEMA and the Town of Mooresville.

Floods caused by the overflow of White Lick Creek and East Fork White Lick Creek were studied in detail within the extraterritorial limits. Initially, in the Type 15 Flood Insurance Study (Reference 1), these streams were studied only within the corporate limits.

2.2 Community Description

The Town of Mooresville, located in central Indiana, 15 miles southwest of Indianapolis, has a population of 7,000 (Reference 2). It is bordered by unincorporated areas of Hendricks County on the north and by unincorporated areas of Morgan County on all other sides. The economy of the area consists primarily of agricultural concerns, with small industrial development consisting of generator rebuilders, brickfacing and industrial equipment manufacturing.

The climate is typical of the Midwest with hot, humid summers and cold winters. Rainfall averages about 36 inches per year.

White Lick Creek, which flows south at the west of Mooresville, originates in southern Boone County, Indiana, approximately 30 miles north of Mooresville, and empties into the White River approximately 10 miles south near Centerton, Indiana. East Fork White Lick Creek flows to the east of Mooresville and joins White Lick Creek about one mile south of the southern corporate limits. Most of the Town of Mooresville is located on land 20 to 60 feet above the normal flow elevation of the streams being studied. The majority of the residential sections of the town are situated in areas above the flood plain, but there is some commercial development south of the town in low-lying areas. Runoff in the area is high due to the shallow clays underlain by bedrock in the form of fissured limestone.

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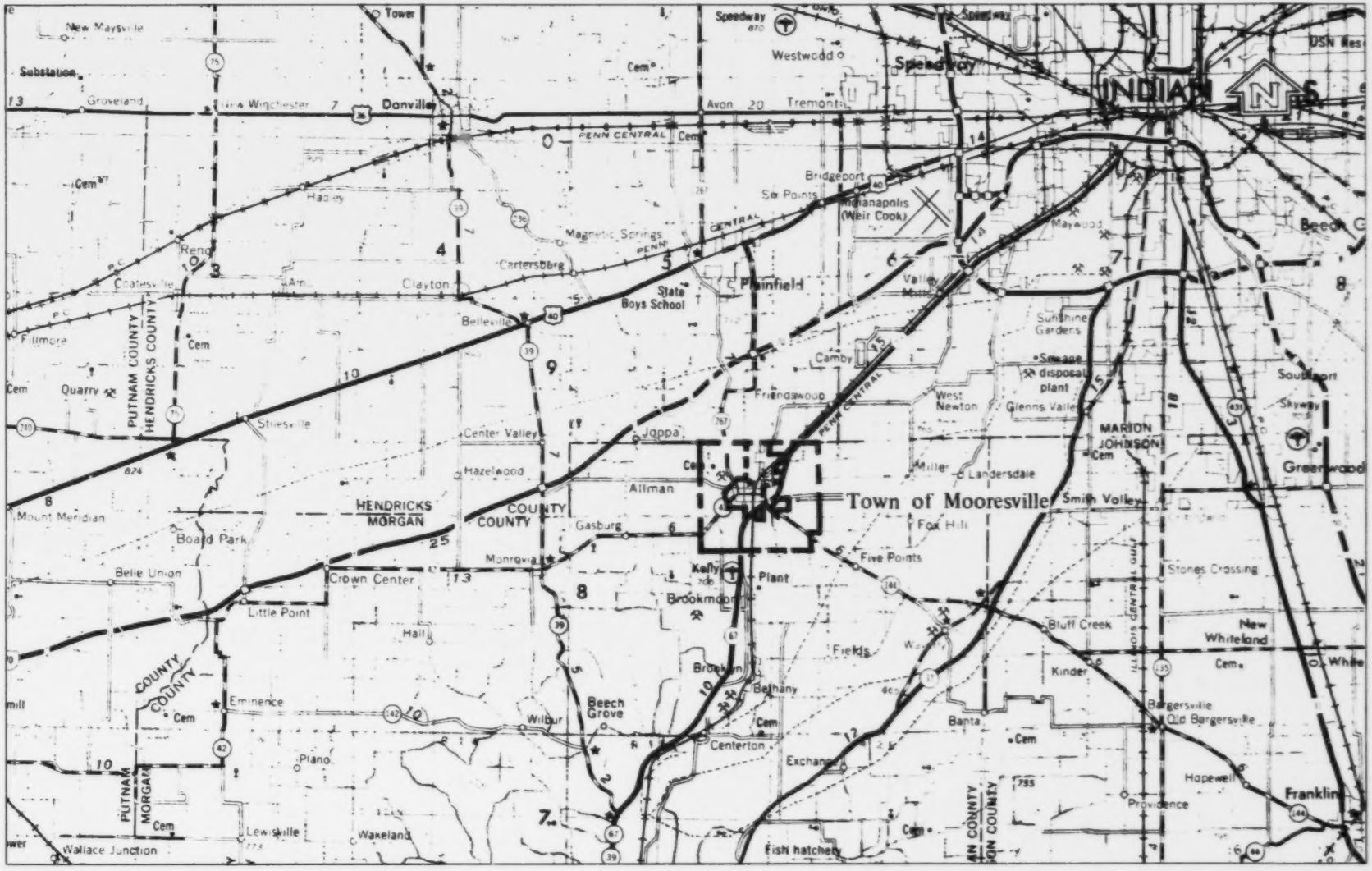

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAN CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

2.3 Principal Flood Problems

Farmlands lying on the west and south sides of Mooresville sustain the greatest damage from flooding by White Lick Creek. Flooding in the major residential areas is rare; however, flooding has occurred at a shopping center in the southern part of the town.

Flooding on East Fork White Lick Creek is confined to portions of a public park on the northeast side and undeveloped and cemetery property on the southeast. Major flooding in the area has occurred in 1913, 1938, 1955, 1957, 1960, 1961 and 1963. The 1961 flood was estimated as a 10-year flood on East Fork White Lick Creek and the 1963 flood was estimated as a 25-year flood on White Lick Creek.

2.4 Flood Protection Measures

There are no structural flood protection measures in the area affecting flooding in Mooresville.

Nonstructural measures of flood protection have been utilized based on information contained in the previous Type 15 Flood Insurance Study (Reference 1).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 per cent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one per cent chance of annual occurrence) in any 50-year period is about 40 per cent (four in ten), and for any 90-year period, the risk increases to about 60 per cent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

Peak discharge data for the selected recurrence intervals for White Lick Creek and East Fork White Lick Creek were determined through use of a log-Pearson Type III analysis (Reference 3). Gaging stations on White Lick

Creek at Mooresville (21 years of record) and on West Fork White Lick Creek at Danville (20 years of record) provided the data for this analysis. A regional relationship relating basin characteristics to streamflow discharges was used as a comparison to the above methodology (References 4 and 5).

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES*

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WHITE LICK CREEK					
Above confluence with East Fork White Lick Creek	214.0	15,200	21,000	23,500	29,500
Above confluence with McCracken Creek	188.0	13,600	18,800	21,000	26,400
EAST FORK WHITE LICK CREEK					
At Mouth	51.9	4,900	7,000	7,850	10,100

* Data taken from Type 15 Flood Insurance Study (Reference 1)

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Cross section data for the streams in the area were obtained from aerial photographs (scale 1:4800, contour interval two feet) and U.S. Geological Survey (USGS) topographic maps (scale 1:24000, contour interval five feet) (References 6 and 7); below-water sections were obtained by field measurements. Elevations and structural data for bridges were obtained from Indiana State Highway Bridge Plans or by direct field measurement.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map.

The roughness coefficients (Manning's "n") were estimated by field inspection at each cross section. Roughness coefficients for White Lick Creek ranged from 0.035 to 0.05 for the main channel and from 0.08 to 0.12 for the overbanks. Roughness coefficients for the main channel of East Fork White Lick Creek ranged from 0.03 to 0.06 and from 0.06 to 0.14 for the overbanks (Reference 1).

The starting water-surface elevation for White Lick Creek was taken from the Flood Insurance Study of Morgan County (Reference 8). Starting water-surface elevations for the East Fork White Lick Creek were determined by slope-area method. Water-surface profiles for the 10-, 50-, 100- and 500-year floods were developed using a HEC-2 step-backwater computer model (Reference 9).

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using USGS maps enlarged to a scale of 1:4800 with 10-foot contour intervals (Reference 10).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain

development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The State of Indiana, however, as set down by the Indiana Flood Control Act of 1945 and the Natural Resources Commission Policy Guidelines, Section 6, adopted March 28, 1974 (Reference 11), has designated that encroachment in the flood plain is limited to that which will cause no significant increase in flood height. As a result, no more than 0.1-foot surcharge has been delineated for this study. The floodways shown in this report were approved by the Indiana State Natural Resources Commission when the review process was completed.

The floodways recommended for this study were computed based on engineering judgment and equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2).

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
WHITE LICK CREEK								
A	51,400	1438[2]	13,327	1.8	662.0	662.0	662.1	0.1
B	52,600	2230[2]	16,909	1.4	662.7	662.7	662.8	0.1
C	56,887	1874	18,977	1.2	668.0	668.0	668.0	0.0
D	60,785	1750	14,972	1.6	669.8	669.8	669.8	0.0
E	61,943	1945	14,228	1.7	670.1	670.1	670.1	0.0
F	64,904	3050	21,153	1.0	673.6	673.6	673.6	0.0
G	67,004	3505	9212	2.3	674.7	674.7	674.7	0.0
H	69,204	2212	10,169	2.1	677.2	677.2	677.2	0.0
EAST FORK WHITE LICK CREEK								
A	370	1438[2]	13,327	1.8	662.0	656.1[3]	656.1	0.0
B	2370	2230[2]	16,909	1.4	662.7	658.0[3]	658.0	0.0
C	4170	1466	4609	1.7	663.5	659.5[3]	659.5	0.0
D	5570	487	2138	3.7	663.5	661.2[3]	661.2	0.0
E	7070	360	2163	3.6	663.5	663.5	663.5	0.0
F	7553	240	1240	6.3	664.6	664.6	664.6	0.0
G	7793	283	1523	5.2	665.5	665.5	665.5	0.0
H	8521	500	3265	2.4	667.8	667.8	667.8	0.0
I	10,521	1027	4179	1.9	668.9	668.9	669.0	0.1
J	13,717	1041	4725	1.7	672.1	672.1	672.1	0.0
K	16,143	1314	6117	1.3	676.3	676.3	676.3	0.0
L	17,783	608	1795	4.4	677.0	677.0	677.0	0.0

[1]FEET ABOVE MOUTH
[2]COMBINED FLOODWAY WIDTH OF WHITE LICK CREEK AND EAST FORK WHITE LICK CREEK
[3]ELEVATIONS WITHOUT CONSIDERING OVERFLOW EFFECT FROM WHITE LICK CREEK

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAN CO.)

FLOODWAY DATA

WHITE LICK CREEK - EAST FORK WHITE LICK CREEK

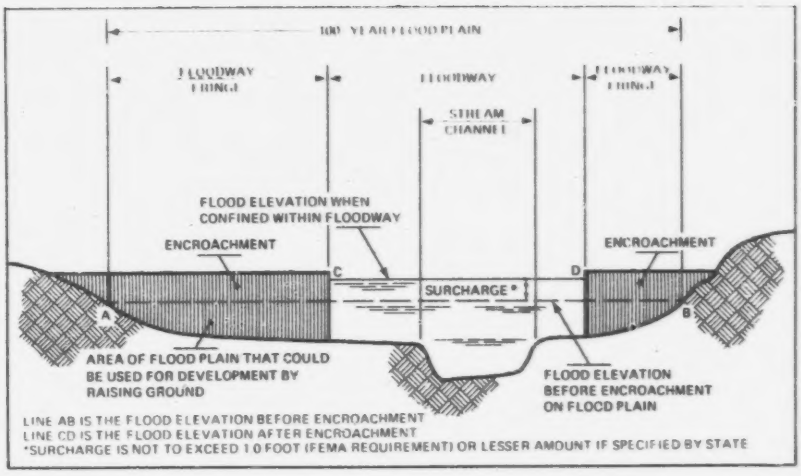
100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the Town of Mooresville.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 per cent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the Town of Mooresville are shown on the Flood Profiles and are summarized in Table 3, "Flood Insurance Zone Data."

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5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the Town of Mooresville was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zones A3, A5:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
WHITE LICK CREEK							
REACH 1	0001,0003	–2.4	–0.7	1.9	025	A5	VARIES–SEE MAP
EAST FORK WHITE LICK CREEK							
REACH 1	0001,0002,0003	–1.5	–0.4	1.0	015	A3	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

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TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAN CO.)

FLOOD INSURANCE ZONE DATA

WHITE LICK CREEK - EAST FORK WHITE LICK CREEK

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of Mooresville is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by FEMA.

6.0 OTHER STUDIES

The flood profiles and flood boundaries for White Lick Creek and East Fork White Lick Creek presented in this study do not match the Type 15 Flood Insurance Study for the Town of Mooresville (Reference 1) due to changes in the starting water-surface elevations. For the same reason, the flood profiles for White Lick Creek and East Fork White Lick Creek in the Flood Insurance Study of Hendricks County, Indiana (Reference 12) do not match this study. The Flood Insurance Study of Morgan County, Indiana (Reference 8) is in exact agreement with this study.

The USGS has published a Map of Floodprone Areas, which includes the Mooresville area. These maps delineate an "Estimated Area Occasionally Flooded" or "Floodprone Area." The flood boundaries for these areas are estimated from profiles based on high water marks (Reference 13). The USGS report is in agreement with this study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 300 South Wacker Drive, (24th Floor), Chicago, Illinois 60606.

8.0 REFERENCES AND BIBLIOGRAPHY

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2. Indiana State Chamber of Commerce, Indiana Industrial Directory, Indianapolis, Indiana: Cornelius Printing Company, 1974.

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4. U.S. Geological Survey, Circular 710, Floods in Indiana: Technical Manual for Estimating Their Magnitude and Frequency, Indiana Department of Natural Resources, Indianapolis, Indiana, 1974.

5. ————, Water Resources Data for Indiana, Water Year 1975, Indiana Department of Natural Resources, Indianapolis, Indiana.

6. Air Map Inc., Aerial Photographs, Scale 1:4800, Contour Interval two feet: Mooresville, Indiana, December 15, 1976.

7. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Interval five feet: Mooresville West, Indiana, 1965; Mooresville East, Indiana, 1965; Plainfield, Indiana, 1970; Bridgeport, Indiana, 1966.

8. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Unincorporated Areas of Morgan County, Indiana, June 1981.

9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water-Surface Profiles User's Manual, Computer Program 723-X6-L202A, Davis, California, 1976.

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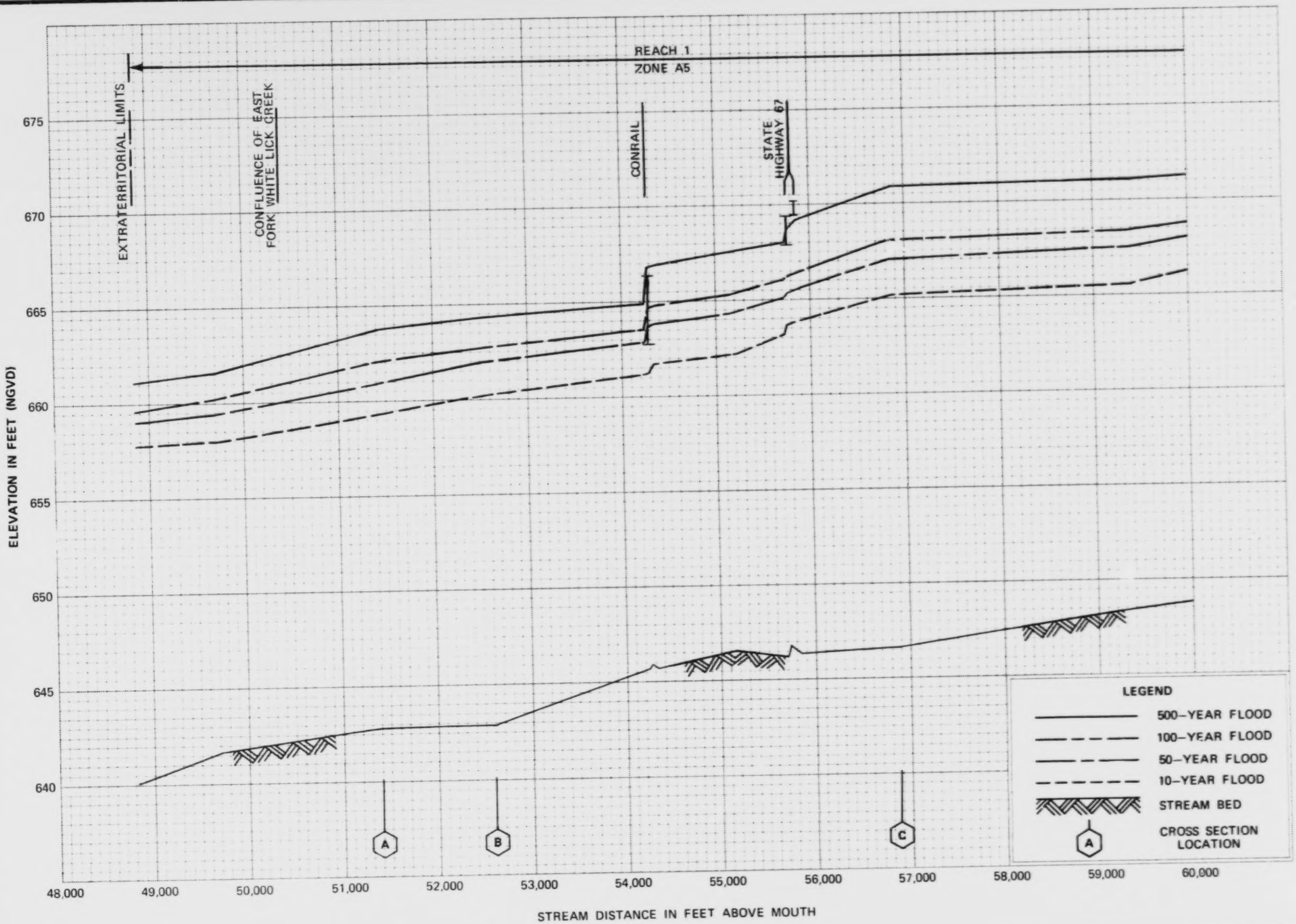
11. Indiana Department of Natural Resources, Guidelines for Delineation of Floodways and Flood Hazard Areas, March 28, 1974.

12. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Unincorporated Areas of Hendricks County, Indiana, March 1981.

13. U.S. Geological Survey, 7.5 Minute Series Topographic Maps of Floodprone Areas, Scale 1:24000, Contour Interval ten feet: Mooresville West, Indiana, 1969; Mooresville East, Indiana, 1976.

————, Drainage Areas of Indiana Streams, Indiana Department of Natural Resources, Richard E. Hogart, Indianapolis, Indiana, 1975.



FLOOD PROFILES

WHITE LICK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAN CO.)

01P

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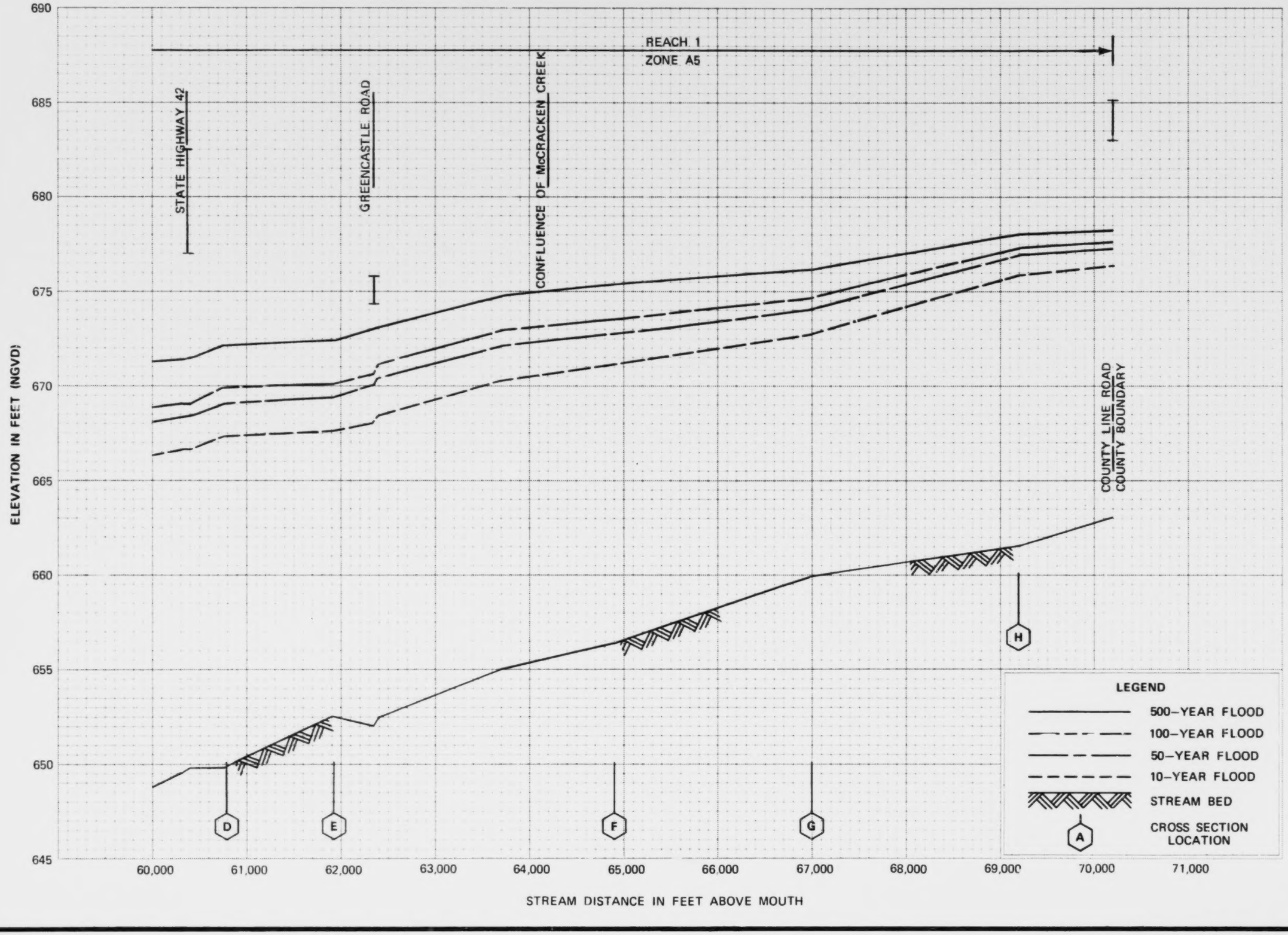

FLOOD PROFILES

WHITE LICK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAN CO.)

02P

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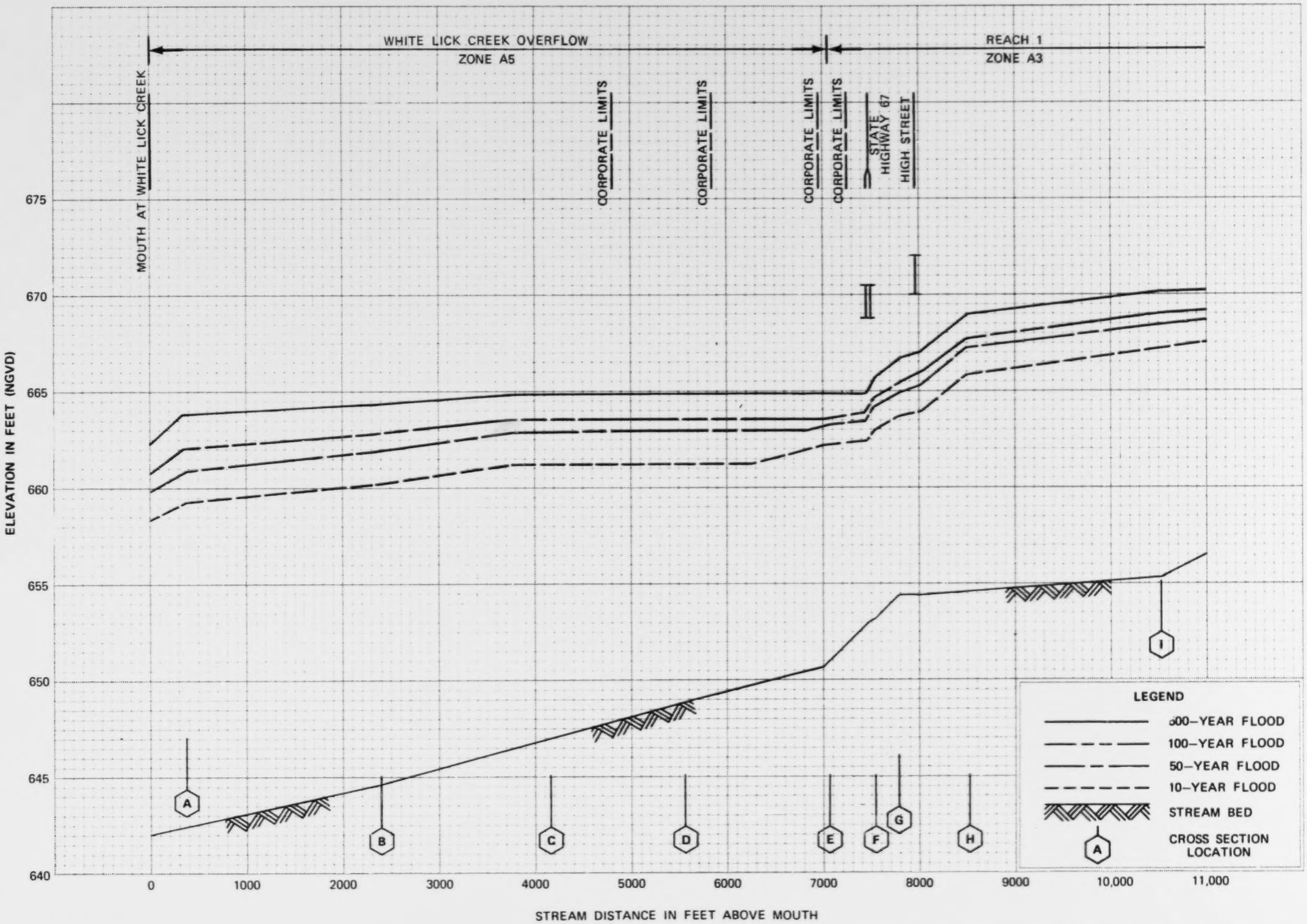

FLOOD PROFILES

EAST FORK WHITE LICK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAM CO.)

03P

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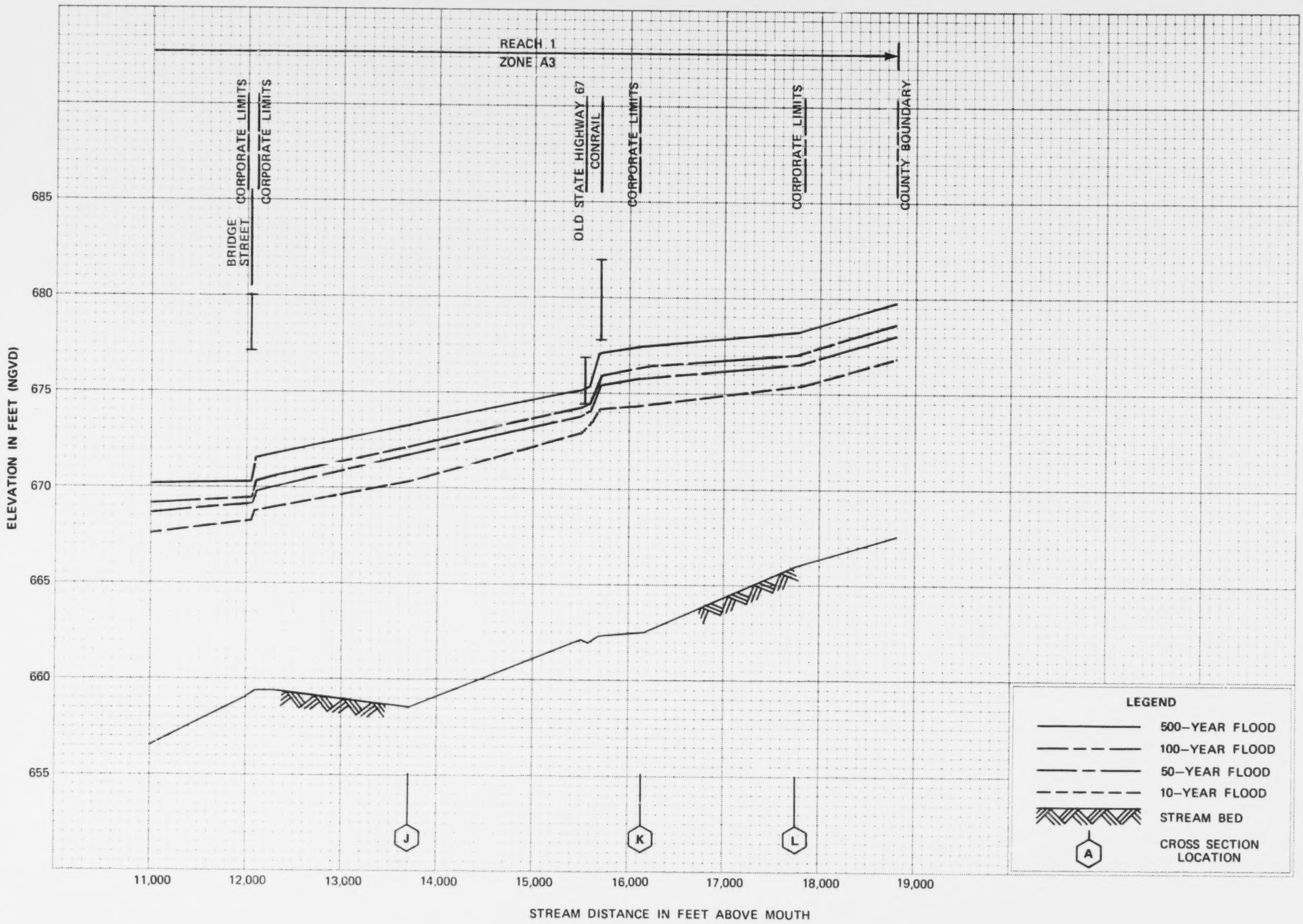

FLOOD PROFILES

EAST FORK WHITE LICK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF MOORESVILLE, IN
(MORGAN CO.)

04P

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